ART. XIX.—*The Framework of the Earth*; by W. M. DAVIS.

For ten or twenty years past, the discussion of various large, super-national questions has held an important place in the proceedings of geological meetings and congresses, national and international; but international action of large dimensions has not yet been undertaken with respect to the greatest of all geological problems, the framework of the earth as a whole. Such action should no longer be delayed. Astronomy has very naturally anticipated other sciences in internationalizing its studies, because its realm is extra-terrestrial and belongs alike to observers in all nations. Geologists may now to advantage follow the lead of the astronomers and, without hampering individual initiative or interfering with national surveys, attack the problem of the earth's framework in an international spirit, for all countries are parts of the same planet.

The present essay closes with a somewhat definite proposition towards that end, which may be at once outlined in this paragraph. The framework of the earth, as determined by all available recorded observations, has been studied in the broadest manner possible by the late Eduard Suess of Vienna; the conclusions reached are summarized in masterful fashion in his great work, "*Das Antlitz der Erde*." An English translation, "*The Face of the Earth*," has been prepared by Miss Sollas of Oxford and published several years ago; Emmanuel de Margerie of Paris has lately completed a French translation, "*La Face de la Terre*." Thus the results of the great Austrian's life work are now available in three languages. Some of his generalizations are well established; others are not so well assured for lack of data. The less assured generalizations can be best tested by directing attention to certain significant areas in which observations are wanting. Indications of these significant areas and of the particular problems that they contain would be welcomed by the geologists of the world as a guide to their future work; particularly if the indications were made by the one man most competent for such a task of all men now living; and that man is without question the scholarly translator of the French edi-

tion of Suess's work. It is with the object of calling attention to the completion of de Margerie's translation and to the importance of securing from him the necessary indications regarding the most desirable lines for super-national geological investigation of the earth's framework that this essay is prepared.

The time is fitting for international and super-national work of this kind. Never has the earth as a whole been so closely scrutinized in many relations by its many inhabitants. Never has the need of world-wide investigation been realized so fully. Never has there been a broader recognition of the value of international coöperation in the solution of great scientific problems. The actual gathering of large international congresses for scientific objects may be delayed for a time by reason of the turmoil that follows the Great War; and, as is well known, certain nations that have heretofore taken an active part in science will not be invited to attend international congresses for the present; but national and international committees are already at work on various broad questions, and the outlining of truly terrestrial investigations for discussion at the next international geological congress, whatever nations may be invited to take part in it, should not be longer deferred. In view of the leading position that de Margerie may, it is to be hoped, be persuaded to take in relation to the future super-national investigation of the earth's framework, special attention will here be given to the position that he now holds in this great subject. But a retrospect over Suess's work must first be taken.

The well-defined object of Suess's studies was to determine the general structure of the earth's crust and to infer therefrom the character of the larger movements by which the crust has been deformed. The method that he pursued in this great endeavor led him first to examine all pertinent geological records, wherever published; then to group the relatively local areas therein treated with respect to the larger structural units, usually of super-national dimensions, to which the areas belong; and finally to discuss the manner in which adjacent structural units are related to one another. Thus the work as a whole truly constitutes a treatise on the framework of the earth, and as such it well deserves to be ranked as the greatest geological treatise ever written. It dif-

fers fundamentally from the most advanced and most voluminous text-books of geology; they proceed systematically through accounts of the constituents which make up the crust, of the processes by which the crust is modified, of the formations which the processes have produced in historical sequence, and of the organic records therein preserved. The author of "*Das Antlitz der Erde*" began where even the greatest of the text books end; and with the expertness attainable only by the long-continued application of a powerful intellect to a great subject, compressed into his treatise a masterful account of the external anatomy of our planet. His volumes are at once so profound and so comprehensive that their pages can be fully appreciated only by geological experts of wide training. Among these the present writer does not venture to range himself; for while the conclusions which Suess reached are of much interest and importance to geographers as well as to geologists, a geographer cannot, even if he has the needed preparation, take the time required for the thorough reading and digestion of all the analytical and synthetic pages in which Suess's conclusions are set forth; although like more devoted students of the great work, he must admire the profusion of learning and the breadth of treatment that the many pages represent.

Every reader of these volumes must be impressed with the vast accumulation of good material upon which they are based; an accumulation that is certainly creditable to geological science. Naturally enough, it is not complete. Observations in certain regions are still insufficient to serve as the basis for safe generalization; for example, large parts of the Andes are frankly left over for future discussion in the absence of competent records now available. No one can realize these deficiencies so fully as the masterful author must have done while pursuing his researches. Nevertheless the great number of well-certified records already published regarding the larger part of the continents suffices to reveal the main structural elements of the earth's framework; and this is truly gratifying for a science that is but little over a century old. Hutton's "*Theory of the Earth*," Playfair's "*Illustrations of the Huttonian Theory*," and William Smith's "*Strata Identified by Organized Fossils*" are famous British examples of the beginnings of

geology at the end of the eighteenth and the opening of the nineteenth centuries; but these and other early works were necessarily based upon imperfect knowledge of restricted fields, the observational study of which had not been standardized. Some of their generalizations were inevitably incorrect; yet the old masters were wise in many of their speculations, and their writings are still profitable reading, if only to learn how great a present-day science has been built up from the foundations that they and their contemporaries laid down a century ago.

Lyell provided in his "*Principles of Geology*," a broader establishment, through the middle of the nineteenth century, for many of the generalizations that his predecessors had formed. His great contribution to earth science was the fuller demonstration that gratuitous overdrafts made out by geological speculators on the Bank of Terrestrial Forces must be returned, marked "No Funds." Yet that able and fair-minded uniformitarian nowhere gave adequate treatment to the great problem of mountain-making; and he was so little constrained by the historical geology of the continents, as known in his time, that he felt free to suggest a fundamental rearrangement of land and water at so late a date as the Pleistocene, in order to account for the climatic changes which the Glacial period demands. Even when the latest of his own revisions of the "*Principles*" appeared, geological exploration was so little advanced that no general summary of earth structure was legitimately possible.

Still less possible was it some fifteen years earlier, when Elie de Beaumont announced his venturesome scheme regarding a geometrical arrangement, a "pentagonal network," of violently upheaved mountain ranges. It is interesting to recall that this scheme was set forth in an essay originally intended to give a summary of the science of geology in d'Orbigny's "*Dictionnaire universelle d'histoire naturelle*"; but as the dictionary was too far advanced for the essay to appear under G, it was named "*Montagnes*," and thus postponed to M, so that the busy author might have more time for its preparation. When M was approached, the essay, still belated, was renamed "*Soulèvements et Révolutions du Globe*"; and when "*Soulèvements*" was reached the essay was again deferred to "*Systemes de Montagnes*." In the meantime the manuscript had far

outgrown the space allotted to it; hence only part of it appeared in the dictionary: the completed statement, still set up in the narrow form of dictionary columns, came out in three small but thick volumes in 1852. The system thus set forth now seems to have been more illuminated by lamplight than by daylight. In the very country where the pentagonal network longest held ground under the authoritative teaching of its inventor, it has now been completely replaced by the non-geometrical and highly irregular mechanistic system, as it may be called, which the great Austrian geologist has developed, and which many French geologists have in recent years done much to support.

It is not the intention of this article to attempt a review of Suess's conclusions; their general nature may be apprehended from a chapter in the final part of the work entitled "Analyses," in which the chief results gained in the previous volumes are summed up, especially with regard to the leading structural elements of the earth, among which, although they are of different nature and area, instructive comparisons may be instituted. The chief and best known of these are: Laurentia in northern America, a vast area of ancient rocks on which Cambrian strata still lie horizontal and on which no Mesozoic strata were deposited until the time of the great Cretaceous transgression. (2) The Caledonids, a belt of pre-Devonian folding, which stretches from northern Ireland across Scotland and western Scandinavia to Spitzbergen. (3) The vast Eurasian edifice, the greatest of all the elements, with its medial area of "Angara" in northern Asia, like Laurentia in consisting of ancient rocks on which horizontal Cambrian strata lie unconformably; this medial area being bordered on the south by great mountain chains of medieval or modern origin which frequently show a loop-like arrangement, and which continue so far as to envelop the northern hemisphere; for one wing of the mountain chains stretches far eastward around the border of the north Pacific into the Rocky Mountains of northwest America, and another stretches far westward, possibly as a once continuous land-mass, across the Atlantic into the Appalachian system; thus our Laurentia is enclosed on the southwest and southeast by extensions of the Angaran mountain border. (4) The Gondwana continent, originally extend-

ing as a continuous land mass from middle South America across the then undeveloped Atlantic basin, then widening so as to include all Africa except the folded ranges of its northwestern and far southern borders, and finally crossing the area of the Indian Ocean to the peninsula of India: all this huge element being, like *Laurentia* and *Angara*, long undisturbed and having no Mesozoic cover earlier than the Cretaceous overlap. And so on with five other elements of greater or less size and of more or less definite establishment. Let it be noted in passing that it is because of the transverse or discordant attitude of the present Atlantic basin with respect to the remains of the great crustal elements that formerly crossed it, that its border contrasts so strongly with the tangential or sympathetic attitude assumed by the border of the Pacific basin with respect to its limiting elements: this contrast being one of the most striking characteristics of the earth's larger features.

Next let it be noted that it is especially with regard to the structure and origin of mountain chains that the broad generalizations established by *Suess* have carried geology so far forward from *Lyell's* mountainless uniformitarianism, and so far from *de Beaumont's* fanciful network of violent upheavals: and also very far beyond various other speculations regarding the origin of mountain chains, in which upheavals and compressions were combined in various proportions. For *Suess* showed that all the greater mountain ranges contradict all theories of axial upheaval and two-sided symmetry, and manifest instead a unilateral structure between a backland or interior area, outward from which the unsymmetrical folding and overthrusting of mountain-making deformation has proceeded, and a relatively rigid foreland or exterior area, towards which the overthrust crust advanced, often with a convex frontal border; while a deeply depressed trough, more or less filled with sediments, is usually found in front of or included within the mountain belt of advancing deformation. But although the general structure of mountain ranges thus appears to be correctly worked out, it is highly significant that neither the unit areas of ancient rocks—*Laurentia*, *Angara*, *Gondwana*—nor the mountain ranges that border them can be reduced to any geometrical system. Both the undisturbed areas and the deformed

belts vary in dimensions, in pattern, and in arrangement. If the framework of the earth's crust is modeled on a geometrical plan, the departures from the plan are more conspicuous than the plan itself. Thus while clearly setting forth the dominant structural features of the actual earth, Suess exhibited a fine scientific prudence in not following the Procrustean habit of some of his predecessors, who have attempted to force the framework of the earth to fit a systematic and more or less preconceived scheme. The chapter in which the "Analyses" are summarized must indeed be disappointing to those who expected to find in it the specifications of a patent earth. This restraint from over-generalization is wise: it goes well with the marvellous marshalling of geological records from all parts of the world, in view of which we repeat that Suess's volumes constitute the greatest geological work ever published.

One of the most remarkable features of the work is that its fundamental thesis regarding the asymmetrical structure of mountain chains, which is now supported by so vast a body of evidence, was well developed in the author's epoch-making essay on "*Die Entstehung der Alpen*," published in 1875, before "*Das Antlitz der Erde*" was begun. Various phrases from that essay might be repeated with little modification in the chapter on "Analyses," which forms a closing part of the later three-volume work. Indeed, it is perhaps because of the great success of his main thesis that the author has been led to hold with too great tenacity to certain other early-formed opinions, which find less confirmation in later and wider study. Masterful as the work is, repeated examination of its successive volumes as they appeared has aroused the question whether the adopted method of treatment was sufficiently mobile for so rapidly expanding a science as geology. The enormous erudition of the author and his unending capacity for analysis and synthesis are most admirable; but his mind seems to have been ponderous rather than nimble. Alternative solutions are not always treated with equal hospitality. The method of multiple working hypotheses is not conspicuously employed in the solution of disputable problems.

It is concluded, for example, that *Laurentia* and other ancient areas have been long undisturbed because they

became at an early date more rigid than the rest of the crust, and therefore the adjacent weaker belts suffered crushing and deformation: but this tacitly implies a comparatively uniform application of crushing forces; for if the forces were unequally applied, belts of yielding might be developed in broad areas of uniform resistance. Again the whole discussion of mountain chains has been conducted under the postulate that dislocations and deformations of the crust result from a diminution of earth volume, and that they are all either radial or tangential; yet while tangential movements are recognized as including folding and overthrusting, radial movements are taken to include only down-settlings or subsidences, all vertical upheavals being excluded, except those that result from tangential crushing. A striking example of this narrow thesis is found early in the great work, where Powell's interpretation of the Uinta mountains as an anticlinal upheaval, between less upheaved areas on either side, is reversed into an interpretation of adjoining lateral areas as having been lowered by wide-spread subsidence, while the intermediate anticlinal mass of the Uintas remained relatively fixed.

Nothing better illustrates the ponderosity of Suess's mind than the tenacity with which he held to this thesis in spite of the enormous magnitude of the subsidences that it involves. When the doctrine of no upheavals is applied to an isolated mountain mass like the Harz, the highlands of which exhibit forms of moderate relief eroded upon deformed structures, it has to be supposed that, if the Harz stood still, subsidence must have lowered not only the surrounding land area but also all the oceans of the world and all the continents that did not then emerge from the lowering oceans. This calls for an enormous contraction of the earth. The isolation of every other highland, large or small, that has been accomplished by the subsidence of the surrounding regions at a date different from the dates of other isolating subsidences, similarly involves a great, world-wide contraction. Surely the total diminution of earth volume thus called for is so great that the more economical doctrine of local upheavals should at least be given careful consideration before it is rejected. Yet no sufficient consideration of this open alternative is presented in Suess's works. Instead, the doctrine of subsidence, as if repre-

senting an essential truth, is vividly illustrated by the case of a post standing just beneath the ice of a frozen pond, so that as the water is drawn off the ice above the post remains at a higher level than that of the subsiding ice around it. This illustration is so striking that the unwary reader might fairly regard the doctrine it represents as having been decisively demonstrated; yet a careful search fails to disclose any valid proof of it whatever. The reason for its adoption was simply that Suess, as he frankly states, could not conceive of any telluric mechanism by which an upheaved mass could be long sustained in its upheaved position: hence he settled down upon the doctrine of no upheavals, instead of leaving the question unsettled, as it should have been left in the absence of deciding evidence.

One of the most illegitimate applications of this very questionable doctrine is found in a chapter on the Pacific, in which the occurrence of high-standing atolls is considered. It is there concluded from the scanty records available thirty years ago that all such atolls have essentially the same altitude, and hence that their emergence must be due to the subsidence of the ocean; and confirmation of this is thought to be found in the occurrence of certain terraces of about the same altitude on the Atlantic border of the continents. Yet as a matter of fact, not only are the high-standing atolls very unlike in altitude, but they are also very unlike in the amount of dissection that they have suffered since emergence; hence it must be inferred that their emergence took place at different dates as well as by different measures; and emergences thus characterized are evidently not so well explained by repeated subsidences of the ocean—and of all the islands and continents that did not then emerge—as by local upheavals of ocean-bottom areas in the region of the emerging atolls at different times and by different amounts. As to the terraces on the Atlantic borders of the continents, the records concerning them are by no means sufficient to prove that they have all been emerged by the same amount and for the same length of time; yet without such evidence they are incompetent witnesses to the doctrine of no upheavals.

In still another respect the whole treatment of mountains is inadequate, as has often been pointed out by Suess's reviewers; namely, in the omission of the

changes that mountains have suffered by erosion during and after their first deformation. If this phase of mountain study found its application only in the explanation of their present form, its omission from a treatise on earth-crust structures would be proper enough, even though the treatise be entitled "The Face of the Earth"; but the study of mountain forms, as the joint result of deformation and erosion, has come in the last half-century to be an important means of interpreting the disturbances that the mountains have suffered. It has indeed been thus learned that many mountains owe the altitude they to-day possess not to the tangential deforming forces by which their strata were first crushed, but to forces of later date and simpler action by which, after the first-deformed mass had been eroded to moderate relief at a moderate altitude, it was upheaved with more or less warping and fracturing and with no indication of tangential compression, along lines that are not necessarily coincident with those of its earlier disturbance.

A single example of the manner in which erosional studies bear upon deformational studies may be taken from Suess's first volume, an example of all the more importance because it illustrates a serious danger to which the author of a work of compilation is exposed; namely, that of accepting the conclusions of a distant observer without means of testing their correctness. The case in point is that of the supposed 40,000-foot fault along the western border of the Wasatch range of Utah, as reported by King. Here Suess adopted King's measure, without perceiving that, if a far-advanced cycle of erosion be interpolated between the folding of the Wasatch rocks and the faulting of the Wasatch range, the measure of faulting may be reduced to a quarter or less of King's extravagant estimate. As to the acceptance of conclusions reported by the many observers cited, it is not to be questioned that Suess as a rule exercised excellent judgment and sagacity; but as to the omission of erosional processes from a study of the face of the earth, this would seem to be because the physiographic method of investigation employed in the interpretation of these processes was not embraced in Suess's view of geological science, and that he never acquired it. Erosional processes were omitted because he did not understand their application: and in view of their omission it

is the framework of the earth rather than its face that "Das Antlitz der Erde" treats.

In spite of these various omissions and limitations, the framework of the earth is ably treated in Suess's volumes. No one can look them over, much less read them carefully, without experiencing an enlarging expansion of his previous conception as to the content of geological science. The local items through which acquaintance with field geology begins, the areal studies through which it advances, the reports of national surveys through which it is matured, are all far transcended by the comprehensive views concerning the structure and development of earth-crust elements, as Suess has summarized them. In the measure that they are apprehended, one gains a grasp of problems never before imagined, an insight into the possibilities of geological investigation never before realized. Here indeed flows a great main stream of thought, toward which all previous studies are related as gathering rivulets and contributory branches. Here is a broad current of investigation directed to an object of extraordinary dimensions, the full attainment of which may be well regarded as the geological duty of the present century. Great honor is due to the master who opened this highway and led us so far along it. How can we best make further advance? That question will be answered most wisely after we examine the French edition of Suess's masterpiece.

Imagine the courage and patience involved in undertaking the translation of a voluminous work, the completion of which in more than 3,000 pages of large octavo print has occupied over a quarter century! Such were the qualities possessed and such is the task accomplished by de Margerie in bringing out "La Face de la Terre," the French version of "Das Antlitz der Erde." The project was conceived in 1890, and the first volume of the translation, the original of which had been published in two parts in 1883 and 1888, appeared in 1897, with a preface by Bertrand. For the second volume the German and French dates are 1888 and 1900; for the third, which like the first was issued in parts, the dates of the original are 1901 and 1909, and of the translation, 1902, 1911, 1913 and 1918. It is the completion of this great undertaking by the appearance of the last of these final parts, bearing an admirable portrait of Suess as a frontispiece and

closing with a graceful epilog by Termier, that we here celebrate.

Seventeen collaborators have translated thirty-five chapters of the imposing work, but de Margerie himself, besides supervising the whole, has translated the other twenty-three chapters or roughly two-fifths of the whole; and for good measure he has added many illustrations and a vast number of bracketed footnotes, and has prepared a supplementary volume of 258 pages containing an elaborate table of contents and index, concerning all of which more is said below. The completion of the work has naturally been delayed by the Great War; the press of Diéval, employed by the publishing house of Colin, had to be removed from one side of Paris to the other as a safeguard against a threatened advance of the Germans; and the paper of the final parts is somewhat lighter than that previously employed, as if indicating a war-time economy. To carry through a scientific task of such magnitude during the strain of a frightful invasion deserves mention along with the completion of the subterranean canal near Marseilles and the finishing of the tunnel under the Pyrenees in the same period of fateful stress.

It is by no means a simple translation that de Margerie has given us. "*La Face de la Terre*" is not the work of a mere bilinguist, but of a scholarly geologist, to whom the literature of his science is known by content as well as by title as to no other man now living. Yet the French version is thoroughly loyal in presenting the meaning expressed by the Austrian author in the original work, unmodified by occasional better interpretations that have come from later studies. Only very rarely is the correction of an unsound generalization introduced, and then always in recognizable form, as in the footnote which briefly states that the latest researches do not support the distinction which Suess had adopted between volcanic rocks of the Atlantic and the Pacific basins. Where technical German terms are not completely represented by the French equivalents, the German words are repeated in parentheses. Readers who prefer the simple directness of French to the complicated inversions of German may therefore rest assured that they will find in "*La Face de la Terre*" all the substance that is contained in "*Das Antlitz der Erde*."

But they will find more; for de Margerie has used his marvellous bibliographic knowledge to enrich the translation by adding a vast fund of references as well as a large number of illustrations not contained in the original work; all these additions being pointed out with scrupulous conscientiousness, the new references enclosed in brackets, and the new illustrations marked with an asterisk in the index volume, where all maps and figures are conveniently grouped geographically in a separate list. The French translation thus serves even better than the German original as an introduction to the structural geology of the world, with especial reference to such problems as are most directly related to the study of earth-crust elements. The use of the translation is moreover facilitated by an excellent index, representing an enormous amount of fatiguing work; it occupies 176 pages of the supplementary partial volume, and contains upwards of 8,000 headings with over 50,000 page references. The French version is, therefore, destined to become the working basis of the future investigations, which it is to be hoped will be the main and great outcome of Suess's studies.

As such, "*La Face de la Terre*" may be used to great profit by advanced students who set out, under the guidance of their professor, upon a winter's indoor campaign to acquire mental possession of a selected crustal element; not alone with the object of learning its structure as described by Suess, but also with the intention of testing the accuracy of his descriptions and generalizations by confronting them with the new material to which de Margerie's added references lead. Such a campaign must, to be successful, be conducted in the neighborhood of a good depot of munitions, where the geological literature of the world is accessible. In case the campaign cannot be undertaken because the near-by depot—or library—is deficient in material, let the librarian be urged to complete his collection by ordering as soon as possible all the works to which reference is made in the original and the added footnotes of "*La Face de la Terre*." Any library thus equipped will be a geological stronghold indeed.

Yet even with a well-stocked library at hand, how difficult is the studious reading of Suess's work, in whatever language it is attempted! Its pages abound in place

names, the location of which had doubtless become familiar to the erudite author by long study; they must become similarly familiar to the student-reader before he can fully acquire Suess's meaning; for of what avail are Simferopol, Hierlatz, Matchin, Dobrogea, and Theodosia, which occur on one single page, and Tummo, Tassili, Azdjer, Mouydir, Issaouan, Temassinnin, Ahnet, Gou-rara, Tin'ret, and Homra, which occur on another, so long as their relative positions are unknown. Evidently if the spacial relations of the formations and structures here described are to be correctly visualized all these place names must be looked up and identified on maps.

It is the same with names of fossils, such as *Ceritium concinnum*, *Proto rotifera*, *Ostrea longirostris*, and with names of rocks, such as ophrite, tonalite, tephrite, and stronalite, and with the names of formations such as Lutétien, Rhétien, Hercynian, and Westphalien; for all these words are likely, from whatever language they may be derived, to be Greek to most students, unless the reading of the text in which they are so plentifully strewn is interrupted long enough to learn their real significance; and significance they surely have, otherwise they would not be introduced. But after their significance is learned by patient plodding, the student will do well to present to his associates a general statement of the matters at issue, and to omit from this statement as many local and technical names as possible.

A winter's campaign of the kind here suggested would surely profit those who carried it through; but it is not as a text-book for even the most advanced university classes that "La Face de la Terre" best serves. The book is a compendium of earth structure for the use of mature geologists; it represents the most advanced line of professional research, from which a general forward movement by experts the world over should be made upon regions not yet occupied. The study of its learned pages will inspire the exploring geologist to new efforts. The Andes, for example, as already said, remain incompletely treated for lack of records. How impatiently must we older workers wait for the results of new researches there by our younger colleagues of whatever nation! How welcome would be a research fund, administered nationally or internationally, from which support could be given to well equipped and well-directed geological enterprise

of the kind here suggested; and how abundantly sufficient would such a fund be, if it were provided in appropriate measure by captains of mining industry who have so largely profited from the work of geological experts in the past, and who are learning to depend more and more upon such work in the future!

Yet even without such an imagined fund—the realization of which is, however, by no means only a remote and fanciful dream—the working geologists of the world will, while fortifying the positions already gained, push forward from them and transform new territory from geological barbarism to geological civilization. Just as the last half-century has seen nearly all the blank spaces on the geographical map of the world filled in with outlines of their larger topographic features, so the next half-century will see the blank spaces on the geological map of the world invaded and taken possession of by an international color scheme. But for such a movement a geological commander-in-chief of international reputation is needed to direct the operations of the new offensive; and this commander must not only be thoroughly informed as to the strength or weakness of the points already held; he must also have a broad view of the terrane over which the advance is to be made, in order to direct the attack where it can be delivered to best advantage.

It is a great good fortune for geological science that precisely such a commander is now living in the person of Emmanuel de Margerie. He is a man of wide personal acquaintance; a thorough scholar in geology and geography, extraordinarily familiar with all books and maps bearing on earth science, and possessing an intellect that represents Gallic agility rather than Teutonic ponderosity. Moreover, he possesses a minute acquaintance with all the chapters of the German and the French volumes, through having either worked them over in the translations of others or translated them himself. He can, better than anyone living, point out the districts in which new observations are needed to verify the supposed extensions of elements of crustal structure; his advice regarding fields that need special attention will, therefore, be most helpful to exploring geologists. He, more penetratingly than any other geologist, can indicate those parts of Suess's generalizations and theories which

need inspection and corroboration, and to which further work should therefore be directed. If the restraint exercised in the translation of "*La Face de la Terre*" were withdrawn, a critical evaluation of the whole work by its translator would be of immense assistance to the geologists of the world. And the same translator might be, more safely than anyone else, entrusted with the preparation of supplementary bulletins, to be issued at intervals of from three to five years, in which the progress of geological exploration should be summarized, not so much with respect to the countries in which they are made or to the geological formations which they describe, as with respect to the earth-crust elements to the definition of which they contribute.

Thus a revision and an extension of Suess's work might be internationally conducted. Detailed studies might be made of the exceptional features by which certain elements locally depart from the generalized structure of the elements to which they belong. Wisely directed attention might be given to the ancient deformations of the long afterwards undisturbed regions, like Laurentia and Angara and Gondwana; and coördinated effort might thus be made to extend the beginnings already outlined in the direction of interpreting the Archean framework of the earth, upon which the more modern framework that Suess deciphered has been superposed.

Where can our efforts towards the attainment of these geological ends be best begun? In my opinion, formed in as detached and impartial a manner as possible, the United States is at present the country best adapted for the beginning, because we, of all the nations geologically competent for so great a task, are also of all the larger nations least impoverished by the Great War. We are indeed likely for some years hence not to retrench our undertakings as an aid toward recuperation, but rather to extend our enterprises in evidence of our undiminished strength; we shall probably embark upon a career of world-wide activity, scientific as well as commercial, and on a greater scale than ever before. It behooves us all to see that that career shall be well wisely planned and well conducted; and it behooves the geologists among us to enlarge our vision to the utmost in order than our share in the coming enterprises shall not be neglected.

A movement is indeed now under foot to invite M. de Margerie to spend next winter with us, visiting various universities and talking with their professors and advanced students in geology on such questions concerning the framework of the earth as he regards most interesting, either because they are already well demonstrated, or because they are most in need of being better demonstrated. If he comes to this country he will undoubtedly be asked to attend the winter meeting of the Geological Society of America where he might give an address on the future exploration of the framework of the earth; and it is to be hoped that that vigorous Society may offer to publish, at such intervals as de Margerie shall deem fitting, the bulletins above mentioned in which the progress of exploration of earth-crust elements shall be summarized, provided he undertakes their preparation. It is possible that the Council of the Geological Society will plan a symposium for some future meeting, open to all members, on the great question of world structure; as a result of which all later communications might, in so far as they deal with structural problems, be habitually presented as parts of and in relation to the earth-crust elements within which they stand, just as stratified formations are now habitually presented with reference to the standard time-scale of historical geology. As a further step toward the desired end of systematic worldwide exploration, a committee of the Society might be appointed to coöperate with the Geology and Geography Division of the National Research Council and with the International Research Council of National Scientific Academies, in encouraging research along the lines that it is to be hoped de Margerie will indicate.

It is now about forty years since Suess began "*Das Antlitz der Erde*," and thirty years since de Margerie began its translation. The half-century anniversary of either of those dates would be a fitting occasion on which to celebrate the progress in the study of earth framework to which they lead the way; and such a celebration would be the natural opportunity at which an international study of earth framework should be reported. The opening of the year 1920 is none too early to lay plans toward such an end.